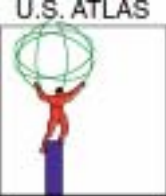




## 3.4 Tile Calorimeter

Larry Price



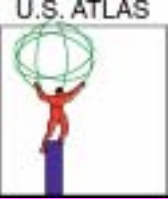
# ATLAS Tile Calorimeter (1.4)

Readout  
system in  
Girder 1.4.3

Intermediate  
Tile  
Calorimeter  
1.4.4

Extended Barrel Calorimeter  
Mechanics 1.4.1  
Optics 1.4.2

- 
- A 3D cutaway diagram of the ATLAS Tile Calorimeter. The diagram shows a large cylindrical structure with a blue outer shell and a green inner core. The core is composed of many small, wedge-shaped tiles arranged in a radial pattern. The diagram is labeled with various components and their properties.
- $\eta$  coverage up to 1.6
  - placed behind the EM LAr accordion ( $\sim 2\lambda$ )
  - outer diameter 8.5 m, 12.2 m long, 2900 tons, 64 wedges structure
  - Fe-scintillator sampling calorimeter (ratio  $\sim 4:1$ ), WLS fibres readout
  - unconventional scintillator geometry, with tiles in the radial direction
  - the calorimeter body and the massive iron outer support act as magnetic flux return for internal solenoid



# US Tile Institutions

## Argonne National Laboratory

- Mechanical design and analysis
- Construction of submodules and modules
- Instrumentation
- Shipping
- Test beam and calibration

## University of Chicago

- Electronic design
- Front end and interface board construction
- Test beam and calibration

## University of Illinois

- Submodule construction
- PMT purchase and testing

## Michigan State University

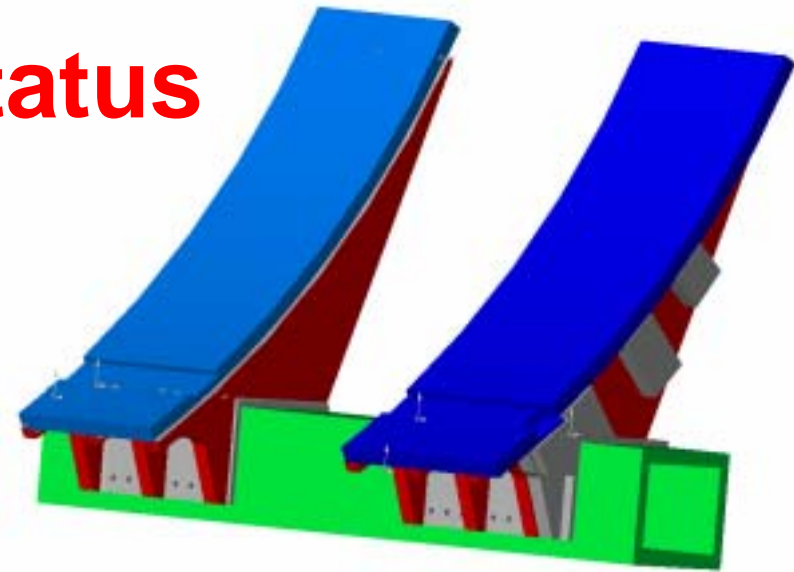
- Instrumentation
- ITC scintillator

## University of Texas at Arlington

- ITC submodules and scintillator
- PMT purchase and testing

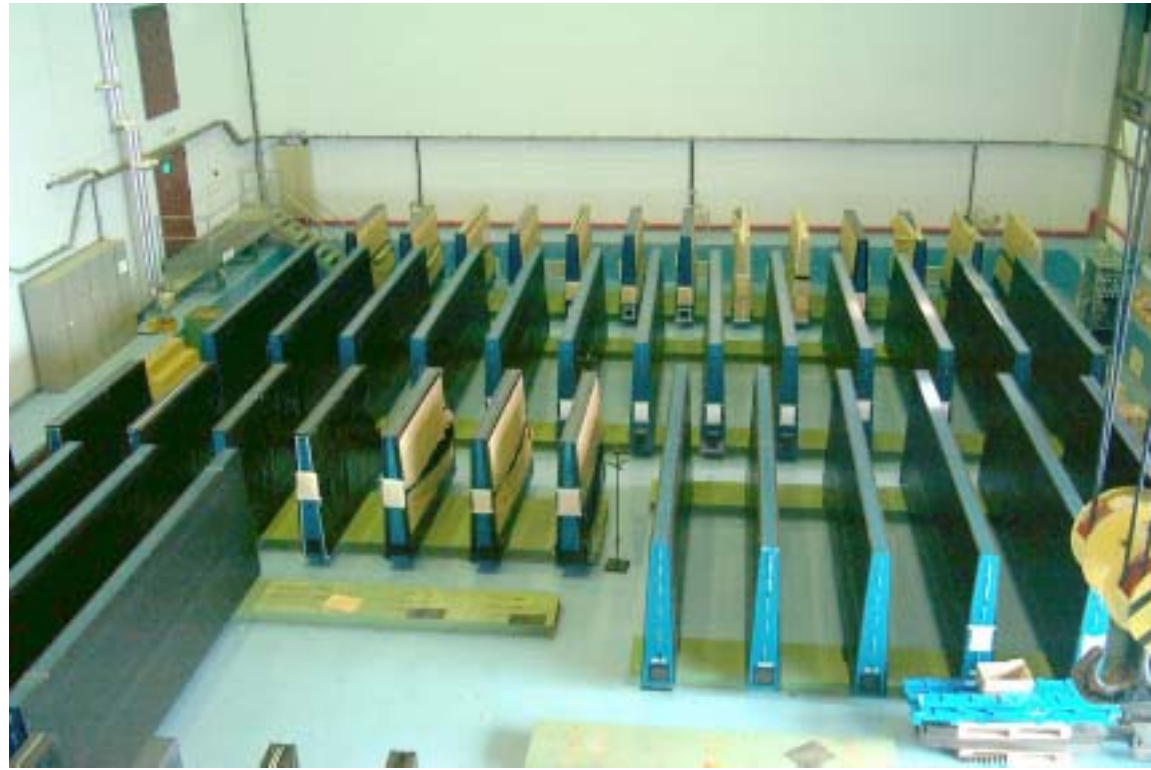


# Deliverables and Status



## • 1.4.1 Mechanics

- ◆ Submodule construction is complete
  - ▲ 596 total
- ◆ Girder production & delivery is complete
- ◆ All 65 modules mechanically assembled, instrumented, and tested
- ◆ 56 completed modules have been shipped to CERN
- ◆ Final shipment to CERN is driven by space at CERN
- ◆ Saddle design complete

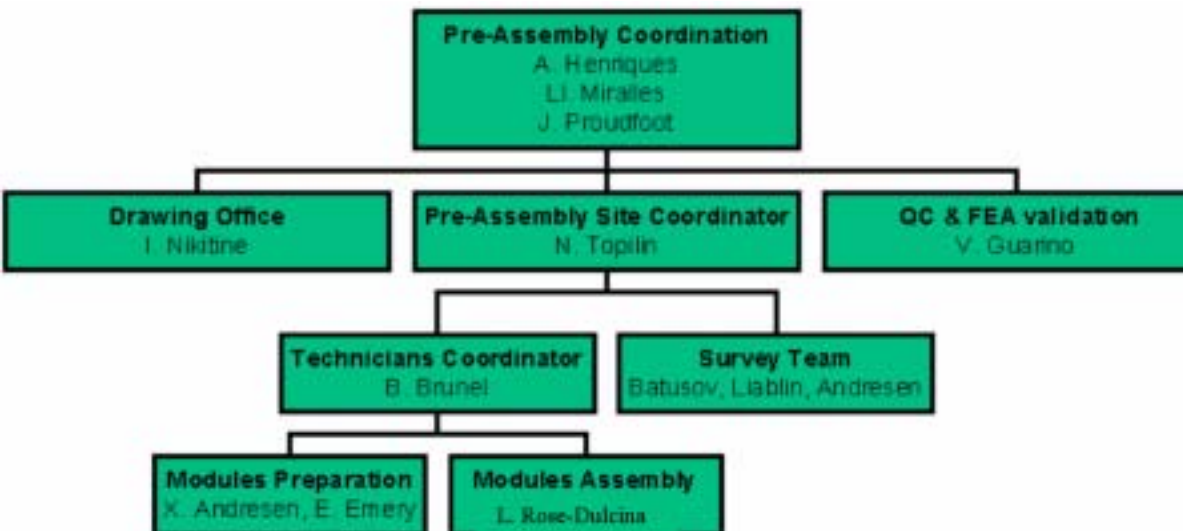




# Deliverables and Status

## • 1.4.1 Mechanics

- ◆ Installation tasks under way with preassembly in building 185 (compare pictures with previous page)
- ◆ First saddle is delivered, repaired, and incorporated in preassembly





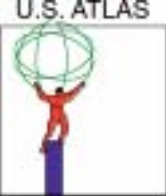
# Deliverables and Status

## • 1.4.2

### Instrumentation

- ◆ 64 EB modules completed (of 65)
- ◆ All modules meet 10% uniformity specification
  - ▲ But a few early modules have been repaired at CERN

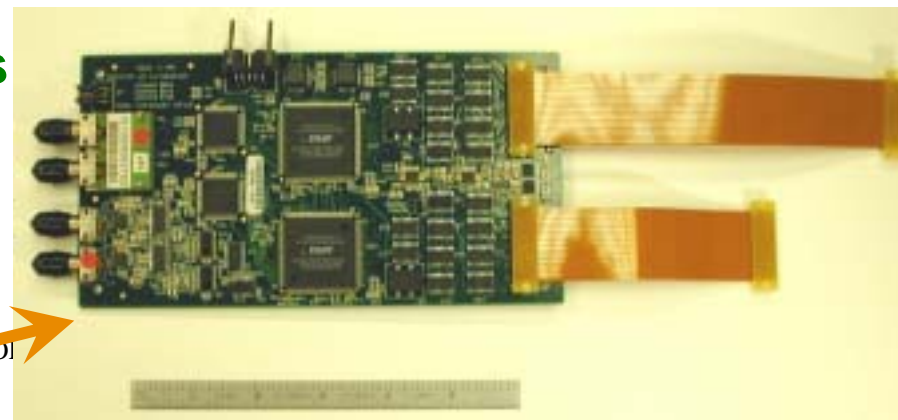




# Deliverables and Status

## • 1.4.3 Readout

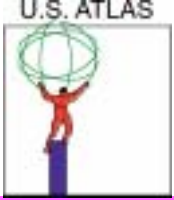
- ◆ STEP1 Testing completed for all 3500 Hamamatsu R-7877 PMTs (UI, UTA)
- ◆ STEP2 underway for last handfull.
- ◆ 69 PMTs rejected & replaced (~ 2%)
- ◆ Breakdown problem discovered in base
- ◆ Front end 3-in-1 cards (10,600) complete
- ◆ Mother Boards
  - ▲ All shipped, but TTC mezzanine boards being reworked to meet new specs of TTC chip
- ◆ Optical Interface Cards
  - ▲ All delivered
  - ▲ 90% tested and shipped to CERN





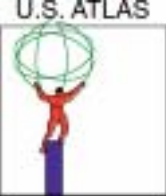
# Technical Status

- **1.4.4 Intermediate Tile Calorimeter**
  - ◆ Finished submodule production in May, 2002
  - ◆ Built 2 spares in June
  - ◆ About to place order for gap scintillator
  - ◆ Final drawings approved for crack (cryostat) scintillator boxes



# Tile Construction: What's Left?

- Ship final modules to CERN when space exists
- Complete rework and testing of TTCrx boards
- Gap scintillators
- Preassembly EBC 10/02 – 4/03
- Preassembly Barrel 5/03 - 12/03
- Preassembly EBA 2/04 - 6/04
- Install Barrel-EBC-EBA 5/04 – 11/05
- Commissioning and Testing 2002-2006
- LHC turnon 2007



# Critical Milestones

Cylinder	Preassembly Start-end date	Assembly in the pit start-end (Schedule_V6)
EBC	Oct 02 - Apr 03	Oct 04 - Feb 05
Barrel	May 03 - Nov 03	May 04 - Oct 04
EBA	Feb 04 - Jun 04	May 05 - Sep 05



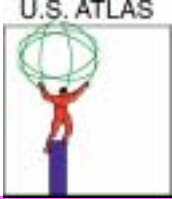
# Critical Milestones

- **Commissioning and Integration**
  - ◆ Began June 2002
  - ◆ Continue through LHC turnon
- **Maintenance and Operations**
  - ◆ Integrated with C&I before turnon
  - ◆ Continues while ATLAS takes data



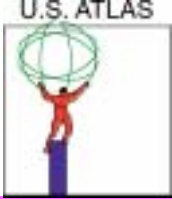
# M&O Plan

- **Pre-Operations**
  - ◆ **Mechanical Support**
    - ▲ Module Validation (before preassembly; recheck before installation)
    - ▲ Integration (follows installation of each section)
  - ◆ **Electrical Support**
    - ▲ Validation, Repairs, and Checkout (before preassembly; recheck before installation)
    - ▲ Integration (follows installation of each section)
    - ▲ Pre-operational testing and checkout (C&I after installation)
  - ◆ **Software Support**
- **Operations (Beam-on)**
- **Maintenance (Beam-off)**
- **Calibration & Monitoring**
  - ◆ **Cs<sup>137</sup> source in each module; set gains; beam test 1/8 of modules before installation**



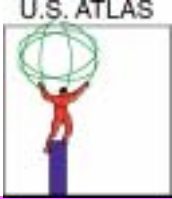
# Model of Maintenance and Operations

- **Mechanical work when endcaps are withdrawn for shutdown maintenance**
  - ◆ Moving of endcaps
  - ◆ Removing electronics drawers for repair
  - ◆ Attachment of  $\text{Cs}^{137}$  drive system
- **Electrical calibration, monitoring, and repair**
  - ◆ Data taking and analysis while running
  - ◆  $\text{Cs}^{137}$  data during shutdowns
  - ◆ Removal and repair of faulty PMT and readout boards
- **Beam tests of reference modules**



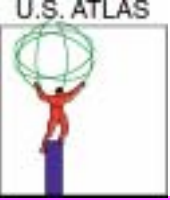
# Deferred (MC) Items

- **1. Electrical validation, repairs, and checkout (\$99K FY04, \$88K FY05)**
  - ◆ This is already a shared activity, with US groups taking the lead. We will attempt to increase effort from non-US groups. Almost certainly, the result will be triage, with the level of testing compromised, so that a large percentage of faults are found and repaired, but more subtle problems are deferred to the C&I phase after installation, when extraction of drawers must be scheduled around installation of other systems.



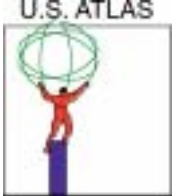
# Deferred (MC) Items

- **2. Calibration and Monitoring Pre-ops (\$48K FY04, \$25K FY05)**
  - ◆ This is a shared activity, with partial US leadership. A probable fallback option is not to set gains during this step and to defer that step to Cs<sup>137</sup> operations after installation. This compromise will lose the tracking of stability that has been planned, whereby the first in-place Cs<sup>137</sup> measurements will permit a check of gain changes after 1.5-2 years.



# Deferred (MC) Items

- **3. Electrical Integration (\$16K FY04, \$53K FY05)**
  - ◆ US contributions will be smaller than anticipated, but not zero. Unless this item can be restored, we will attempt to work with our collaborators so that non-US groups do more of the early work and the US contribution is partially deferred.
- **4. Electrical Software support (\$80K FY04)**
  - ◆ We will start this work a year later than scheduled, with the consequence that supported views of cosmic ray and data from calibration systems become available that much later. With this work deferred, the cushion of examining the system over a longer time period before turnon is removed.



# M&O Cost Profile

## U.S. ATLAS M&O Estimate WBS Profile Estimates

Funding Source: All

Funding Type: Research Program

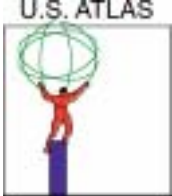
3/31/03 8:23:53 AM

Institutions: All

Estimate in Fixed FY'03 \$k

Labor/Material: Both

WBS Number	Description	FY 03 (k\$)	FY 04 (k\$)	FY 05 (k\$)	FY 06 (k\$)	FY 07 (k\$)	FY 08 (k\$)	FY 09 (k\$)	FY 10 (k\$)	FY 11 (k\$)	FY 12 (k\$)	Total (k\$)
3	U.S. ATLAS M&O Estimate	613	432	620	881	1075	717	716	715	784	715	7266
3.4	Tile Calorimeter System	613	432	620	881	1075	717	716	715	784	715	7266
3.4.1	TileCal - Specific Costs	388	297	445	663	923	555	555	555	623	555	5557
3.4.1.1	Pre-Operations	388	297	445	650	220	0	0	0	0	0	2000
3.4.1.2	Operations (Beam-on)	0	0	0	0	488	400	400	400	400	400	2490
3.4.1.3	Maintenance (Beam-off)	0	0	0	13	215	154	154	154	223	154	1067
3.4.2	Calibration & Monitoring	204	114	154	200	29	29	29	29	29	29	850
3.4.2.1	Pre-Operations	204	114	154	200	0	0	0	0	0	0	673
3.4.2.2	Operations (Beam-on)	0	0	0	0	29	29	29	29	29	29	177
3.4.2.3	Maintenance (Beam-off)	0	0	0	0	0	0	0	0	0	0	0
3.4.3	Tilecal System Common Costs	21	21	21	19	123	133	132	131	131	131	860
3.4.3.1	Operations	21	21	21	19	123	133	132	131	131	131	860



# FTE Summary

## MANPOWER ESTIMATE SUMMARY IN FTEs per

WBSNo: 3.4

Funding Type: Research Program

3/31/03 8:26

Description: Tile Calorimeter System

Institutions: All

Funding Source :

	<i>FY03</i>	<i>FY04</i>	<i>FY05</i>	<i>FY06</i>	<i>FY07</i>	<i>FY08</i>	<i>FY09</i>	<i>FY10</i>	<i>FY11</i>	<i>FY12</i>	<i>Calculated Total</i>
Faculty											.0
Sr Research Scientist											.0
Term Scientist											.0
Post Doc											.0
Grad Student											.0
Mechanical Engineer	.2	.2	.2	.2	.5	.2	.2	.2	.2	.2	2.5
Electrical Engineer	.5	.2	.2	.2	.5	.2	.2	.2	.2	.2	2.6
Technical	2.6	.6	.9	3.5	2.8	1.9	1.9	1.9	1.9	1.9	20.0
Computer Designer	.5	.3	.9	1.4	1.6	1.0	1.0	1.0	1.0	1.0	9.7
Administrator											.0
General Labor		1.7	1.9								3.6
<b>TOTAL LABOR</b>	3.8	3.1	4.2	5.4	5.5	3.3	3.3	3.3	3.3	3.3	38.5

1760 Hours per FTE year